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Patent Abstract

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EPB 1998-05-27 0661446/EP-B1 **A fuel injector with an integrated spark plug for a direct injection type engine**

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A fuel injector with an integrated spark plug for a direct injection type engine capable of adequate fuel injection and adequate spark discharge, even if it becomes very hot because the end part of device is exposed in a combustion chamber and a spark discharge is induced there.An electric conductor (3,4,5) is disposed along the central axis, and the electric conductor (3,4,5) is electrically coupled with a cable (2) for supplying electric current for the spark discharge. A needle valve (7) made of conductive material is electrically coupled with the electric conductor (3,4,5) through a return spring (6) made of conductive material and is reciprocally moved by a solenoid (30). A needle housing (8) made of conductive material receives the needle valve (7) and has a nozzle (92) for injecting fuel and a center electrode (9) at its end. A grounding electrode (10) is disposed near the center electrode (9). Insulators (11,12) are disposed outside of the electric conductor (3,4,5). Outside of the insulators (11,12), an outer cylinder is disposed, which is composed of inner wall (21) which adheres to the insulators (11,12) and outer wall (28) which is placed outside of the inner wall (21) at a uniform clearance which is used as a fuel passage. A connector assembly (40) for connecting a fuel line and an electric cable for supplying electric current to the solenoid (30) is attached to the outer cylinder (28).
EXEMPLARY CLAIMS- A fuel injector with an integrated spark plug for a direct injection type engine, comprising:; an electric conductor (3, 4, 5) disposed along the central axis, said electric conductor (3, 4, 5) being electrically coupled with a cable (2) for supplying electric current for a spark discharge;; a needle valve (7) made of conductive material, said needle valve (7) being electrically coupled to said electric conductor (3, 4, 5) through a return spring (6) made of conductive material, said needle valve (7) being reciprocally moved by a solenoid (30);; a needle housing (8) made of conductive material, said needle housing (8) receiving said needle valve (7) and having a center electrode (9) at its end;; a grounding electrode (10) disposed to oppose said center electrode (9);; an insulator (11, 12, 13, 14, 15) disposed outside of said electric conductor (3, 4, 5);; an outer cylinder (21, 22, 26) disposed outside of said insulator (11, 12, 13, 14, 15), said outer cylinder (21, 22, 26) forming a uniform clearance which is used as a fuel passage; and; a connector assembly (40) for connecting a fuel line and an electric cable (31) for supplying an electric current to said solenoid (30),; an inner wall of said outer

cylinder (21, 22, 26) adheres to said insulator (11, 12, 13, 14, 15) so that said clearance is formed around an outer wall of said outer cylinder (21, 22, 26), and said needle housing (8) has a nozzle (9a) for injecting fuel and slidably receives said needle valve (7) so that a high voltage electric current passes from said needle valve (7) to said needle housing (8) irrespective of their relative positions.; A fuel injector with an integrated spark plug for a direct injection type engine according to claim 1,; said center electrode (9) disposed at the end of said needle housing (8) projects beyond the needle seat portion of said needle housing (8), and said grounding electrode (10) is disposed radially outside the outside surface of said center electrode (9).

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(54) **A fuel injector with an integrated spark plug for a direct injection type engine**

Kraftstoffeinspritzeinrichtung mit integrierter Zündkerze für Motor mit direkter Einspritzung

Injecteur de combustible avec bougie d'allumage intégrée, pour moteur à injection directe

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US-A- 3 830 204

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EP 0 661 446 B1

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Description

The present invention relates to a fuel injector with an integrated spark plug for a direct injection type engine according to the preamble of claim 1.

A fuel injector with an integrated spark plug is developed to be used in a direct injection type engine.

It is required that a fuel injector with an integrated spark plug supplies desired amount of fuel, at a desired timing as a fuel injector and induces a spark discharge with desired intensity, at a desired timing and desired position, as a spark plug.

A fuel injector with an integrated spark plug becomes very hot because the end part of the device is exposed in a combustion chamber and a spark discharge is induced there.

If spark discharge occurs close to a outer surface of a needle housing, the needle housing is made very hot. Therefore, fuel which contacts inner surface of the hot needle housing is heated and tar will deposit in the fuel and the fluidity of the fuel will be deteriorated, so that it will be difficult to inject the fuel adequately.

If an electrode is disposed in the path of a fuel spray injected from a nozzle of injector, fuel will stick to the electrode, then will be exposed in the combustion gas, carbon will deposit on the electrode, and it will be difficult to induce a suitable spark discharge because the gap is not adequate.

Therefore, attention should be paid to the position of the spark discharge in a fuel injector with an integrated spark plug.

Also, it is important to maintain the alignment of the elements which compose a fuel injector with an integrated spark plug in order that the fuel may be injected adequately.

In addition to these points, attention should be paid to the insulation between the electric conductors and other metallic elements so that the solenoid operates correctly to activate needle valve, and so that an adequate spark discharge is induced.

In the fuel injector with an integrated spark plug disclosed in the JP-U-63-154760 (shown in Fig. 5), the fuel passage which is disposed between a yoke and a housing is not symmetrically arranged around the center axis, so that fuel contained inside of the fuel injector is unequally cooled. Therefore, it is feared that strain occurs and the elements do not align accurately and, as a result, fuel is not injected adequately.

Also, the above type fuel injector with an integrated spark plug has insufficient insulation between a central electric conductor and a solenoid. Therefore, it is possible that a high voltage electric current leaks from "e_1" to "e_2"(shown in Fig. 5) and is applied to the solenoid and, as a result, an adequate spark discharge and an adequate injection of fuel is not attainable.

In the fuel injector with an integrated spark plug disclosed in the JP-A-4-54275, a spark discharge occurs outside of the wall of injector inside of which fuel is contained, therefore the fuel is heated and tar will deposit.

A generic fuel injector with an integrated spark plug for a direct injection type engine is known from the GB-A-1 002 694. According thereto, an electric conductor is disposed along a central axis of the injector to which a cable for the supply of electric current for the spark plug is connected. A electromagnetic actuable needle valve of the injector is electrically connected to the electric conductor and transmits the electric current via a needle housing to a center electrode of the spark plug, being connected to the needle housing. Insulators are disposed around the electric conductor. Furthermore, an outer cylinder in the form of a soft iron core is provided which forms a uniform clearance being used as a fuel passage.

It is an object of the present invention to further develop a fuel injector with an integrated spark plug for a direct injection type engine according to the preamble of claim 1 such that an adequate discharge of the spark plug and a reliable injection of fuel is possible under all conditions.

This object is achieved by the features of claim 1.

Advantageous further developments are set out in the dependent claims.

According to the present invention there is provided a fuel injector with an integrated spark plug for a direct injection type engine. The fuel injector with an integrated spark plug for a direct injection type engine comprises, an electric conductor disposed along the central axis and coupled with a cable for supplying electric current for a spark discharge, a needle valve made of conductive material and electrically coupled to the electric conductor through a retum spring made of conductive material and reciprocally moved by a solenoid, a needle housing made of conductive material which receives the needle valve and has a nozzle for injecting fuel and a center electrode at its end, a grounding electrode disposed to oppose the center electrode, an insulator disposed outside of the electric conductor, outer cylinder which is disposed outside of the insulator and includes an inner wall which adheres to the insulators and an outer wall which is placed outside of the inner wall with a uniform clearance which is used as a fuel passage, and a connector assembly for connecting a fuel line and an electric cable for supplying an electric current to the solenoid.

An inner wall of the outer cylinder adheres to the insulator so that the clearance forming the fuel passage is formed around the outer wall of the outer cylinder. Furthermore, the needle housing comprises a nozzle for injecting fuel so that an injection direction is always reliable. Additionally, the needle housing slidably receives the conducting needle valve such that a high voltage electric current passes from the needle valve to the needle housing irrespective of their relative positions. By these means both the ignition of the spark plug and the injection of fuel can be performed without any time limit and without a dependency from each other.

The present invention will be more fully understood from the description of the preferred embodiments of the invention set forth below, together with the accompanying drawings.

In the drawings:

Fig. 1 is a sectional view of an fuel injector with an integrated spark plug of the present invention;
Fig. 2 is a enlarged detail of the lower part of Fig. 1;
Fig. 3A is a enlarged detail of the portion A in Fig. 1;
Fig. 3B is a enlarged detail of the portion B in Fig. 1;
Fig. 3C is a enlarged detail of the portion C in Fig. 1;
Fig. 4 is a enlarged detail of the bottom end portion of an fuel injector with an integrated spark plug of the present invention;
Fig. 5 is a sectional view of an fuel injector with an integrated spark plug of a prior art.

In Fig. 1, reference numeral 1 represents fuel injector with an integrated spark plug for a direct injection type engine.

A high tension cord 2 is connected to a distributor (not shown) at the first end, and is connected to the first end of a first electric conductor 3 at the second end. The other end of the first electric conductor 3 is inserted and connected to one end of a second electric conductor 4 which has a cylindrical shape. Into the other end of the second electric conductor 4, one end of an adjusting bar 5 is inserted and connected.

The adjusting bar 5 is located inside of an adjusting pipe 5a which is set in close contact to the inner surface of a second insulator 12. The adjusting bar 5 and the adjusting pipe 5a are fixed to each other by caulking at position "X" .

The other end of the adjusting bar 5 pushes and contacts one end of a return spring 6, which is made of conductive material.

The other end of the return spring 6 pushes and contacts a top surface of a needle 7, which is made of conductive material. The needle 7 is slidably received in a needle housing 8, which is made of conductive material.

A center electrode is located at the top of the needle housing 8.

A nozzle 9a is located at the center of the center electrode.

As described above, the first electric conductor 3, the second electric conductor 4, adjusting bar 5, return spring 6, needle 7 and needle housing 8 are located along the center axis and high voltage electric current flows in them.

These are insulated by a first insulator 11, a second insulator 12, a third insulator 13, a fourth insulator 14 for positioning and a fifth insulator 15 from a first cylinder 21, a second cylinder 22 with flange, a shim 23, a spur 24, a collar 25, a third cylinder 26, fuel line located body 27, a first housing 28 and a second housing 29.

The top of the second housing 29 surrounds the center electrode 9 and forms a grounding electrode.

A solenoid 30 activates needle 7 when the electric current is supplied through the cord 31 and the fuel is then injected by nozzle 9a.

Connector body 40 is inserted between the first cylinder 21 and the enlarged end of the first housing 28 and locked by a nut 41, therefore the direction of the connector body 40 is freely adjustable, even if the whole unit is attached to the cylinder head of the engine by a threaded connection.

The connector body 40 has an electric connector 42 to connect an outer electric supply wire with the wire 31 and a fuel line connector 43 to connect the outer fuel line to the injector and an inner fuel line 44 to introduce fuel from outer fuel line to a fuel passage between the first cylinder 21 and the first housing 28.

Hereinafter, measures taken for attaining the better performance are described referring Fig. 2 which shows the detail of the lower part of the fuel injector with an integrated spark plug according to the present invention.

To attain a sufficient accuracy, the above described parts are assembled according to the following order:

(1) The needle housing 8 to which O-ring 51 is previously assembled, is installed to the fifth insulator 15 by threading, at portion "S", by rotating the inner hexagonal recess using a hexagonal wrench. In this procedure, gas seal 61 is installed tapered portion "T_1";
(2) Then, the fifth insulator 15, to which needle housing 8 is installed as above, is installed into second housing 29. The fifth insulator 15 contacts with the second housing 29 at part F with good accuracy, so that the O-ring 52 fulfils its sealing function and the center of the fifth insulator 15 and the center of the second housing 29 are coincide with each other at the large diameter portion of. A gas seal 62 is installed tapered portion "T_2";
(3) Then, the fourth insulator 14 for positioning is set on the recess of the fifth insulator 15, and the fuel line located body 27 is set on the fourth insulator 14 for positioning, then the top end of the second housing 29 is bent inwards. Thus, the needle housing 8 having the center electrode 9 at the top, the fifth insulator 15, the fourth insulator 14 for positioning, the fuel line located body 27 and the second housing 29 is assembled.

The fourth insulator 14 for positioning contacts the fifth insulator 15 at the portion "G" and "H", and also contacts with the fuel line located body 27 at the portion "I" and "J", to maintain accuracy;
(4) Then, the seat portion of the inner side of the needle housing 8 is machined and polished by referring to the inner surface of fuel line located body 27 as a fiducial plane, because errors at the threaded portion of needle housing 8 and the fifth insulator 15 and at other parts accumulate and deteriorate the alignment of the central electrode 9 and the fuel

line located body 27; and

(5) The assembly which includes the needle 7, the third insulator 13 and the collar 25 are incorporated. The collar 25 and the fuel line located body 27 should be aligned when assembled, because the collar 25 and the fuel line located body 27 contacts to each other.

To adjust the bias force of the return spring, the adjusting pipe 5a, in which the adjusting bar 5 is previously installed, is stuck to the second insulator 12, then the adjusting pipe 5a is calked at the portion "X "(shown in Fig. 1) after conclusion of the positioning so that a suitable bias force is attained, because the first insulator 11 and the second insulator 12 are made of non-metallic material which are not suitable for calking.

To increase the strength against the combustion pressure, adhesives are applied into the clearance of the screw portion of needle housing 8 and the fifth insulator 15. These parts are then completely fixed, so that more strength is attained.

By receiving the combustion pressure at "J" portion and "H" portion, each having large area, and to calk at portion "A" where the outer diameter is large, less force per unit area is received and, as a result, an advantage is attained in the point of strength.

The collar 25, the second cylinder 22 with flange and the third cylinder 26 which surrounds the solenoid 30 are made of a ferrous magnetic material to form a closed magnetic circuit around the solenoid 30, to prevent the magnetism generated by the solenoid 30 from leaking away. By this way, magnetic field is increased, and a compact construction is attained.

In addition, the fuel line located body 27 and the first cylinder 21 are made of non-magnetic material, for instance stainless steel or the like, to prevent the magnetism from leaking through the third cylinder, collar 25, fuel line located body 27, the second housing 29, cylinder head (not shown) or through the third cylinder 26and the first cylinder 21.

It is important to separate the electric line of ignition system and the electric line of injector system to maintain the reliability and the performance, because the second housing 29 also works as the ground for the spark plug.

Other measures are taken for preventing the high voltage electric current from leaking, and are described below referring Fig. 3A to Fig. 3C.

Fig. 3A is a enlarged drawing of portion "A" in Fig. 1 showing the joint between the first insulator 11 and the second insulator 12. As shown in Fig. 3A, the plane of the joint of the first insulator 11 and the second insulator 12 contacts with the adjusting pipe 5a as a electric conductor in which high voltage electric current flows, at point "a_1", and contacts with the third cylinder 26 which is made of metallic material at point "a_2". Therefore, point "a_1" and "a_2" are connected through the above described plane of the joint. However, the plane of the joint has a cross section of a saw tooth form, and point "a_1" and "a_2" are kept sufficiently distant from each other. Therefore, no spark discharge occurs between the points "a_1" and "a_2".

Fig. 3B is a enlarged drawing of portion "B" in Fig. 1 showing the joint of the first insulator 11 and the second insulator 12. As shown in Fig. 3B, the lower end plane of the second insulator 12 contacts with the return spring 6 as a electric conductor in which high voltage electric current flows, at point "b_1", and contacts with the second cylinder 22 with flange which is made of metallic material at point "b_2". In the same manner, the upper end plane of the third insulator 13 contacts with the return spring 6 at point "b_3", and contacts with the collar 25 which is made of metallic material at point "b_4". Therefore, points "b_1" and "b_2", and points "b_3" and "b_4" are respectively connected through each end plane. However, the each plane has a crank shaped cross section, and points "b_1" and "b_2", and points "b_3" and "b_4" are respectively kept sufficiently distant from each other. Therefore, no spark discharge occur between points "b_1" and "b_2", and points "b_3" and "b_4".

Fig. 3C is a enlarged drawing of portion "C" in Fig. 1 showing the joint of the first insulator 11 and the second insulator 12. As shown in Fig. 3C, the lower end plane of the third insulator 13 contacts with the needle 7 as a electric conductor in which high voltage electric current flows, at point "c_1", and contacts with the collar 25 which is made of metallic material at point "c_2". In the same manner, the inner top of the fifth insulator 15 contacts with the needle housing 8 as a electric conductor at point "c_3", and contacts with the fuel line located body 27 which is made of metallic material at point "c_4". Therefore, points "c_1" and "c_2", and points "c_3" and "c_4" are respectively connected through continuous plane. However, the each plane has a cross section having right angled portion, and points "c_1" and "c_2", and points "c_3" and "c_4" are respectively kept sufficiently distant from each other. Therefore, no spark discharge occur between points "c_1" and "c_2", and points "c_3" and "c_4".

Now the operation of the device is described. Firstly, the operation as a fuel injector is described.

The fuel supplied through the outer fuel pipe enter into the unit from the connecting portion 43 of the connecting body 40. Then the fuel passes through, the inner passage 44 of the connecting body 40, the fuel passage between the first cylinder 21 and the first housing 28, the fuel path between the third cylinder 26 and the first housing 28, and reaches at the fuel line located body 27. Then, the fuel passes through the fuel line which connect the outer and inner portion of the fuel line located body 27 and reaches the inner side of the fuel line located body 27. Then, the fuel passes through the clearance between the third insulator 13 and the fourth insulator 14 for positioning, and reaches the portion which is defined by the shaft 7a of the needle 7, the upper surface of the intermediate guide 7b, the bottom surface of the third insulator 13 and the needle housing 8.

The intermediate guide 7b has a quadrilateral shape while the the inner surface of the needle housing 8 has a round shape. Therefore, the fuel passes through the clearance between the intermediate guide 7b and the needle housing 8, and reaches the portion which is defined by the shaft 7a of the needle 7, the lower surface of the intermediate guide 7b, the upper surface of the top part 7c of the needle 7 and the needle housing 8.

The lower surface of the top part 7c of the needle 7 is cone shaped and is connected to the upper surface by an oblique passage through the top part 7c. Therefore, the fuel can reach the under side of the top part 7c of the needle 7, regardless of the position of the needle.

The conical bottom part of the needle housing 8 has more gentle slope than the slope of the cone shaped lower surface of the top part 7c and has a nozzle 9a.

When an electric current is not supplied to the solenoid 30, the needle 7 is pushed down by the bias force of the return spring 6, and the tip of the top part 7c of the needle 7 enters into the nozzle hole 9a, so that the fuel cannot pass through the nozzle hole 9a.

When an electric current is supplied to the solenoid 30, the needle 7 is pulled up, and the tip of the top part 7c of the needle 7 moves out of the nozzle hole 9a, so that the fuel can pass through the nozzle 9a, and can be injected into the combustion chamber.

Secondly, the operation of the device as a spark plug is described. The high voltage electric current from the distributor reaches the unit through a high-tension cable. The high voltage electric current then passes through the first electric conductor 3, the second electric conductor 4, the adjusting bar 5, the return spring 6, the needle 7, the needle housing 8 and reaches the center electrode 9 which is located at the center of the end of the needle housing 8. A grounding electrode 10 is formed around the center electrode 9. Therefore, a spark discharge occurs at the gap "s" (shown in Fig. 4) between the center electrode 9 and the ground electrode 10.

Accordingly, the center electrode 9, especially the middle part of it, attains the highest temperature and is most easily strained or deformed. However, the required level of the accuracy is lower than that of the portion of the seat where the needle 7 and the needle housing 8 contact with each other.

Conversely, the seat, does not attain a high temperature, strain does not occur and tar will not be deposited from the heated fuel.

As shown in Fig.4, the inner side of the lower end portion of the fifth insulator is kept away from the outer surface of the needle housing 8 by distance "d", for the axial length "L" from the bottom end.

By keeping the inner side of the lower end portion of the fifth insulator 15 away from the outer surface of the needle housing 8 as described above, the needle housing 8 does not take heat away from the insulator 15 too much, and the fifth insulator 15 is not over cooled and no carbon is generated on it.

The heat value of the spark plug can be adjusted by varying the distance "d" and the length "L".

As described above, a fuel injector with an integrated spark plug according to the present invention can supply a desired amount of fuel at desired timing and can also induce a spark discharge with desired intensity, at desired timing and at a desired position.

Claims

1. A fuel injector with an integrated spark plug for a direct injection type engine, comprising:

   an electric conductor (3, 4, 5) disposed along the central axis, said electric conductor (3, 4, 5) being electrically coupled with a cable (2) for supplying electric current for a spark discharge;
   a needle valve (7) made of conductive material, said needle valve (7) being electrically coupled to said electric conductor (3, 4, 5) through a return spring (6) made of conductive material, said needle valve (7) being reciprocally moved by a solenoid (30);
   a needle housing (8) made of conductive material, said needle housing (8) receiving said needle valve (7) and having a center electrode (9) at its end;
   a grounding electrode (10) disposed to oppose said center electrode (9);
   an insulator (11, 12, 13, 14, 15) disposed outside of said electric conductor (3, 4, 5);
   an outer cylinder (21, 22, 26) disposed outside of said insulator (11, 12, 13, 14, 15), said outer cylinder (21, 22, 26) forming a uniform clearance which is used as a fuel passage; and
   a connector assembly (40) for connecting a fuel line and an electric cable (31) for supplying an electric current to said solenoid (30),

   characterized in that
   an inner wall of said outer cylinder (21, 22, 26) adheres to said insulator (11, 12, 13, 14, 15) so that said clearance is formed around an outer wall of said outer cylinder (21, 22, 26), and said needle housing (8) has a nozzle (9a) for injecting fuel and slidably receives said needle valve (7) so that a high voltage electric current passes from said needle valve (7) to said needle housing (8) irrespective of their relative positions.

2. A fuel injector with an integrated spark plug for a direct injection type engine according to claim 1, **characterized in that**
   said center electrode (9) disposed at the end of said needle housing (8) projects beyond the needle seat portion of said needle housing (8), and said grounding electrode (10) is disposed radially outside the

outside surface of said center electrode (9).

3. A fuel injector with an integrated spark plug for a direct injection type engine according to claim 1, **characterized in that** said insulator (15) is disposed around said needle housing (8) and is kept a predetermined distance away from the outer surface of said needle housing (8) for a predetermined distance from the end of said insulator (15).

4. A fuel injector with an integrated spark plug for a direct injection type engine according to claim 1, **characterized in that** said insulator (11, 12, 13, 14, 15) is axially separated into several pieces.

5. A fuel injector with an integrated spark plug for a direct injection type engine according to claim 4, **characterized in that** at their junction, two of said separated insulators (11, 12; 12, 13; 13, 14; 14, 15) are connected to each other in a nested relationship, the axial end of the outer portion of one (11, 12, 13, 14, 15) of said two of said separated insulators (11, 12; 12, 13; 13, 14; 14, 15) having a different axial position compared to the position of the axial end of the inner portion, said axial end of the outer portion which is contiguous at an edge with the outer surface of said insulator (11, 12, 13, 14, 15) which contacts with the inner wall of the outer cylinder (22, 25, 27, 29) being continuous in a stepped configuration with said axial end of the inner portion which is contiguous at an edge with the inner surface of said insulator (11, 12, 13, 14, 15) which contacts the centrally located conductor (4, 5, 6, 7) at an edge.

6. A fuel injector with an integrated spark plug for a direct injection type engine according to claim 1, **characterized in that** said solenoid (30) is surrounded with a ferrous magnetic material (22, 25, 26) so as to make a closed magnetic circuit.

7. A fuel injector with an integrated spark plug for a direct injection type engine according to claim 6, **characterized in that** the parts (21, 27) which connect to the said ferrous magnetic material (22, 25, 26) are made of non-magnetic materials so as to prevent the magnetism from leaking.

8. A fuel injector with an integrated spark plug for a direct injection type engine according to claim 1, **characterized in that** said needle housing (8) is connected to the outer insulator (15) by a threaded portion and adhesives are inserted into the clearance in the threaded portion.

9. A fuel injector with an integrated spark plug for a direct injection type engine according to claim 1, **characterized in that** said electric conductor (3, 4, 5) is made of an outer pipe (4) and an inner bar (5, 5a) which are fixed to each other by caulking after being positioned to attain predetermined bias force of said spring (6).

10. A fuel injector with an integrated spark plug for a direct injection type engine according to claim 1, **characterized in that** said connector assembly (40) for connecting said fuel line and said electric cable (2) can be attached to said outer cylinder (21, 22, 26) regardless of the radial direction.

Patentansprüche

1. Kraftstoffeinspritzeinrichtung mit einer integrierten Zündkerze für einen direkteinspritzenden Motor mit:

einem elektrischen Leiter (3, 4, 5), der entlang der Mittelachse angeordnet ist, wobei der elektrische Leiter (3, 4, 5) mit einem Kabel (2) elektrisch gekoppelt ist, um elektrischen Strom für eine Funkenabgabe zuzuführen;

einem Nadelventil (7), das aus leitendem Material hergestellt ist, wobei das Nadelventil (7) über eine Rückholfeder (6), die aus leitendem Material hergestellt ist, mit dem elektrischen Leiter (3, 4, 5) elektrisch gekoppelt ist, wobei das Nadelventil (7) durch einen Elektromagneten (30) hin- und herbewegt wird;

einem Nadelgehäuse (8), das aus leitendem Material hergestellt ist, wobei das Nadelgehäuse (8) das Nadelventil (7) aufnimmt und an seinem Ende eine Mittelelektrode (9) hat;

einer Masseelektrode (10), die in Gegenüberlage zu der Mittelelektrode (9) angeordnet ist;

einem Isolator (11, 12, 13, 14, 15), der außerhalb des elektrischen Leiters (3, 4, 5) angeordnet ist;

einem äußeren Zylinder (21, 22, 26), der außerhalb des Isolators (11, 12, 13, 14, 15) angeordnet ist, wobei der äußere Zylinder (21, 22, 26) einen gleichförmigen Spalt bildet, der als ein Kraftstoffkanal verwendet wird; und

einer Steckerbaugruppe (40) zum Verbinden

einer Kraftstoffleitung und eines elektrischen Kabels (31), um dem Elektromagneten (30) einen elektrischen Strom zuzuführen,

dadurch gekennzeichnet, daß
eine innere Wand des äußeren Zylinders (21, 22, 26) an dem Isolator (11, 12, 13, 14, 15) haftet, so daß der Spalt um eine äußere Wand des äußeren Zylinders (21, 22, 26) herum ausgebildet ist, und daß das Nadelgehäuse (8) eine Düse (9a) zum Einspritzen von Kraftstoff hat und das Nadelventil (7) gleitfähig aufnimmt, so daß ein elektrischer Hochspannungsstrom von dem Nadelventil (7) zu dem Nadelgehäuse (8) unabhängig von deren relativen Positionen fließt.

2. Kraftstoffeinspritzeinrichtung mit einer integrierten Zündkerze für einen direkteinspritzenden Motor nach Anspruch 1,
dadurch gekennzeichnet, daß
die Mittelelektrode (9), die am Ende des Nadelgehäuses (8) angeordnet ist, über den Nadelsitzabschnitt des Nadelgehäuses (8) hinaus vorsteht, und daß die Masseelektrode (10) radial außerhalb der äußeren Fläche der Mittelelektrode (9) angeordnet ist.

3. Kraftstoffeinspritzeinrichtung mit einer integrierten Zündkerze für einen direkteinspritzenden Motor nach Anspruch 1,
dadurch gekennzeichnet daß
der Isolator (15) um das Nadelgehäuse (8) herum angeordnet ist und von dem Ende des Isolators (15) aus über einen vorgegebenen Abstand um einen vorgegebenen Abstand von der äußeren Fläche des Nadelgehäuses (8) weggehalten ist.

4. Kraftstoffeinspritzeinrichtung mit einer integrierten Zündkerze für einen direkteinspritzenden Motor nach Anspruch 1,
dadurch gekennzeichnet, daß
der Isolator (11, 12, 13, 14, 15) axial in mehrere Stücke getrennt ist.

5. Kraftstoffeinspritzeinrichtung mit einer integrierten Zündkerze für einen direkteinspritzenden Motor nach Anspruch 4,
dadurch gekennzeichnet, daß
zwei der getrennten Isolatoren (11, 12; 12, 13; 13, 14; 14, 15) an ihrer Verbindung in einer verschachtelten Beziehung miteinander verbunden sind, wobei das axiale Ende des äußeren Abschnitts von einem (11, 12, 13, 14, 15) der beiden getrennten Isolatoren (11, 12; 12, 13; 13, 14; 14, 15) verglichen mit der Position des axialen Endes des inneren Abschnitts eine unterschiedliche axiale Position hat, wobei das axiale Ende des äußeren Abschnitts, das an einer Kante mit der äußeren Fläche des Isolators (11, 12, 13, 14, 15) benachbart ist, der sich in Kontakt mit der inneren Wand des äußeren Zylinders (22, 25, 27, 29) befindet, kontinuierlich in einer abgestuften Konfiguration mit dem axialen Ende des inneren Abschnitts ist, der an einer Kante mit der inneren Fläche des Isolators (11, 12, 13, 14, 15) benachbart ist, der sich an einer Kante in Kontakt mit dem in der Mitte befindlichen Leiter (4, 5, 6, 7) befindet.

6. Kraftstoffeinspritzeinrichtung mit einer integrierten Zündkerze für einen direkteinspritzenden Motor nach Anspruch 1,
dadurch gekennzeichnet, daß
der Elektromagnet (30) mit einem eisernen magnetischen Material (22, 25 26) umgeben ist, um einen geschlossenen Magnetkreis zu bilden.

7. Kraftstoffeinspritzeinrichtung mit einer integrierten Zündkerze für einen direkteinspritzenden Motor nach Anspruch 6,
dadurch gekennzeichnet, daß
die Teile (21, 27), die mit dem eisernen magnetischen Material (22, 25, 26) verbunden sind, aus nichtmagnetischen Materialien hergestellt sind, um das Streuen des Magnetismusses zu verhindern.

8. Kraftstoffeinspritzeinrichtung mit einer integrierten Zündkerze für einen direkteinspritzenden Motor nach Anspruch 1,
dadurch gekennzeichnet, daß
das Nadelgehäuse (8) durch einen Gewindeabschnitt mit dem äußeren Isolator (15) verbunden ist und daß Klebstoffe in den Spalt des Gewindeabschnitts eingefügt sind.

9. Kraftstoffeinspritzeinrichtung mit einer integrierten Zündkerze für einen direkteinspritzenden Motor nach Anspruch 1,
dadurch gekennzeichnet, daß
der elektrische Leiter (3, 4, 5) aus einem äußeren Rohr (4) und einer inneren Stange (5, 5a) hergestellt ist, die miteinander verbunden werden, indem sie nach dem Positionieren verstemmt werden, um eine vorgegebene Vorspannkraft der Feder (6) zu erzielen.

10. Kraftstoffeinspritzeinrichtung mit einer integrierten Zündkerze für einen direkteinspritzenden Motor nach Anspruch 1,
dadurch gekennzeichnet, daß
die Steckerbaugruppe (40) zum Verbinden der Kraftstoffleitung und des elektrischen Kabels (2) ungeachtet der radialen Richtung an dem äußeren Zylinder (21, 22, 26) angebracht werden kann.

Revendications

1. Injecteur de carburant avec bougie d'allumage intégrée, destiné à un moteur du type injection directe, comprenant :

   un conducteur électrique (3, 4, 5) disposé suivant l'axe central, ledit conducteur électrique (3, 4, 5) étant relié électriquement à un câble (2) destiné à fournir un courant électrique pour une décharge d'étincelle,
   une soupape à pointeau (7) faite d'un matériau conducteur, ladite soupape à pointeau (7) étant reliée électriquement audit conducteur électrique (3, 4, 5) par l'intermédiaire d'un ressort de rappel (6) fait d'un matériau conducteur, ladite soupape à pointeau (7) étant déplacée selon un mouvement alternatif par un électro-aimant à noyau-plongeur (30),
   un logement de pointeau (8) fait d'un matériau conducteur, ledit logement de pointeau (8) recevant ladite soupape à pointeau (7) et comportant une électrode centrale (9) à son extrémité,
   une électrode de masse (10) disposée de façon à faire face à ladite électrode centrale (9),
   un isolateur (11, 12, 13, 14, 15) disposé à l'extérieur dudit conducteur électrique (3, 4, 5),
   un cylindre extérieur (21, 22, 26) disposé à l'extérieur dudit isolateur (11, 12, 13, 14, 15) ledit cylindre extérieur (21, 22, 26) formant un espace uniforme qui est utilisé en tant que passage de carburant, et
   un ensemble de connecteur (40) destiné à connecter une conduite de carburant et un câble électrique (31) afin d'appliquer un courant électrique audit électro-aimant à noyau-plongeur (30),

   caractérisé en ce que

   une paroi intérieure dudit cylindre extérieur (21, 22, 26) adhère audit isolateur (11, 12, 13, 14, 15) de façon que ledit espace soit formé autour d'une paroi extérieure dudit cylindre extérieur (21, 22, 26), et ledit logement de pointeau (8) comporte une buse (9a) destinée à l'injection du carburant, et reçoit de façon coulissante ladite soupape à pointeau (7) de façon qu'un courant électrique à haute tension passe depuis ladite soupape à pointeau (7) vers ledit logement de pointeau (8) indépendamment de leur position relative.

2. Injecteur de carburant avec bougie d'allumage intégrée destiné à un moteur du type à injection directe selon la revendication 1,

   caractérisé en ce que

   ladite électrode centrale (9) disposée à l'extrémité dudit logement de pointeau (8) fait saillie au-delà de la partie de siège de pointeau dudit logement de pointeau (8), et ladite électrode de masse (10) est disposée radialement à l'extérieur de la surface extérieure de ladite électrode centrale (9).

3. Injecteur de carburant avec bougie d'allumage intégrée destiné à un moteur du type à injection directe selon la revendication 1,

   caractérisé en ce que

   ledit isolateur (15) est disposé autour dudit logement de pointeau (8) et est maintenu à une distance prédéterminée à l'écart de la surface extérieure dudit logement de pointeau (8) sur une distance prédéterminée à partir de l'extrémité dudit isolateur (15).

4. Injecteur de carburant avec bougie d'allumage intégrée destiné à un moteur du type à injection directe selon la revendication 1,

   caractérisé en ce que

   ledit isolateur (11, 12, 13, 14, 15) est séparé axialement en plusieurs pièces.

5. Injecteur de carburant avec bougie d'allumage intégrée destiné à un moteur du type à injection directe selon la revendication 4,

   caractérisé en ce que

   au niveau de leur jonction, deux desdits isolateurs séparés (11, 12 ; 12, 13 ; 13, 14 ; 14, 15) sont reliés l'un à l'autre en relation d'encastrement, l'extrémité axiale de la partie extérieure de l'un (11, 12, 13, 14, 15) desdits deux desdits isolateurs séparés (11, 12 ; 12, 13 ; 13, 14 ; 14, 15) présentant une position axiale différente par comparaison à la position de l'extrémité axiale de la partie intérieure, ladite extrémité axiale de la partie intérieure qui est contiguë au niveau d'un bord avec la surface extérieure dudit isolateur (11, 12, 13, 14, 15) qui est en contact la paroi intérieure du cylindre extérieur (22, 25, 27, 29) étant en continuité suivant une configuration étagée avec ladite extrémité axiale de la partie intérieure qui est contiguë au niveau d'un bord avec la surface intérieure dudit isolateur (11, 12, 13, 14, 15) qui vient en contact avec le conducteur situé de façon centrale (4, 5, 6, 7) au niveau d'un bord.

6. Injecteur de carburant avec bougie d'allumage intégrée destiné à un moteur du type à injection directe selon la revendication 1,

   caractérisé en ce que

   ledit électro-aimant à noyau-plongeur (30) est entouré d'un matériau magnétique ferreux (22, 25, 26) de manière à former un circuit magnétique fermé.

7. Injecteur de carburant avec bougie d'allumage intégrée destiné à un moteur du type à injection directe selon la revendication 6,

caractérisé en ce que

les parties (21, 27) qui sont reliées audit matériau magnétique ferreux (22, 25, 26) sont faites de matériaux amagnétiques de manière à empêcher le magnétisme de fuir.

8. Injecteur de carburant avec bougie d'allumage intégrée destiné à un moteur du type à injection directe selon la revendication 1,

caractérisé en ce que

ledit logement de pointeau (8) est relié à l'isolateur extérieur (15) par une partie filetée, et des adhésifs sont introduits dans l'espace libre de la partie filetée.

9. Injecteur de carburant avec bougie d'allumage intégrée destiné à un moteur du type à injection directe selon la revendication 1,

caractérisé en ce que

ledit conducteur électrique (3, 4, 5) est fait d'un tuyau extérieur (4) et d'une tige intérieure (5, 5a) qui sont fixés l'un à l'autre par sertissage après avoir été positionnés de façon à obtenir une force de poussée prédéterminée dudit ressort (6).

10. Injecteur de carburant avec bougie d'allumage intégrée destiné à un moteur du type à injection directe selon la revendication 1,

caractérisé en ce que

ledit ensemble de connecteurs (40) destiné à connecter ladite conduite de carburant et ledit câble électrique (2) peut être fixé audit cylindre extérieur (21, 22, 26) indépendamment de la direction radiale.

Fig.1

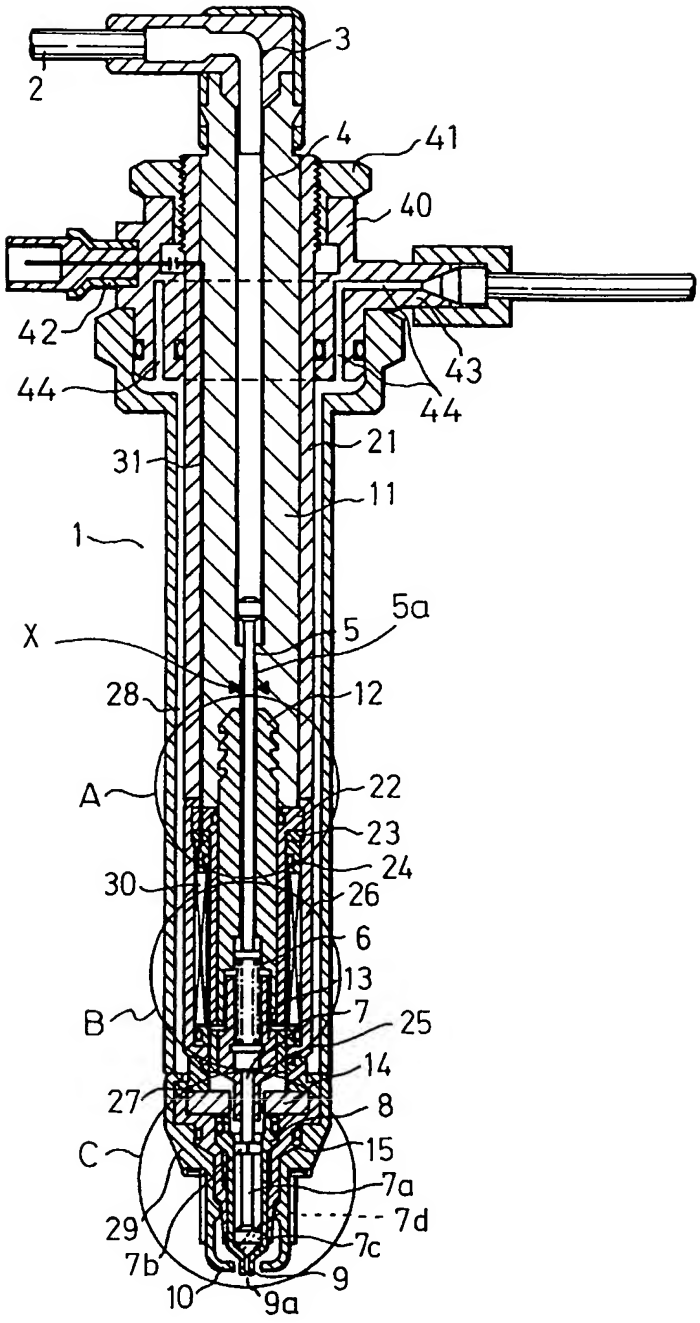
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Fig. 2

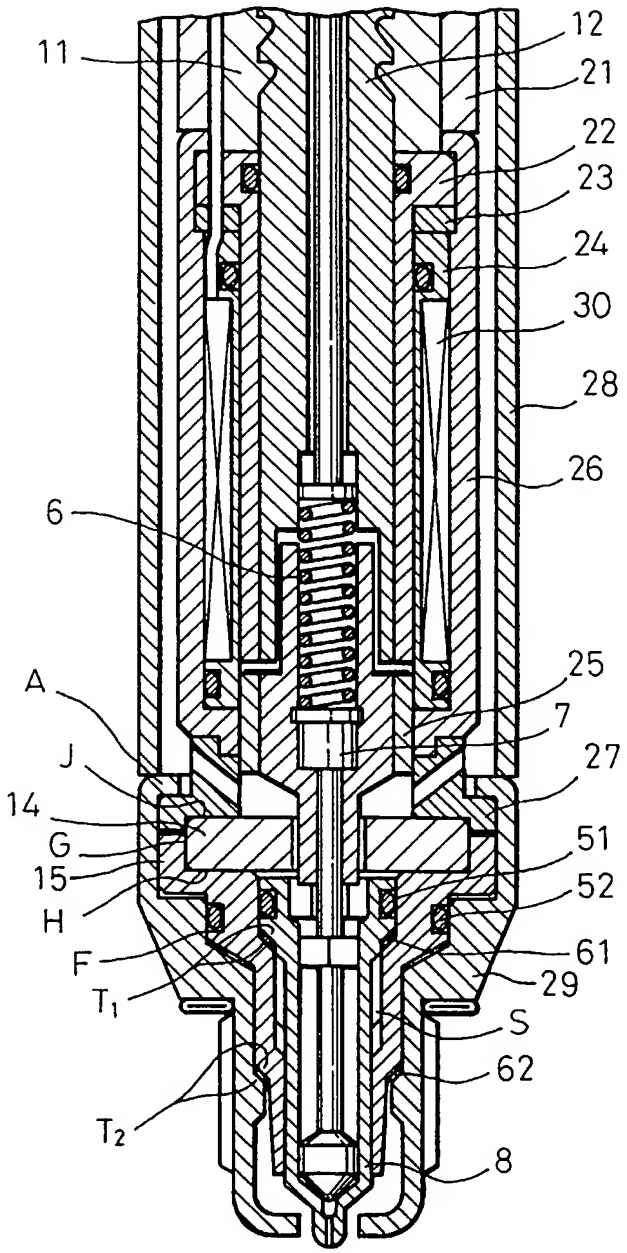


Fig.3A

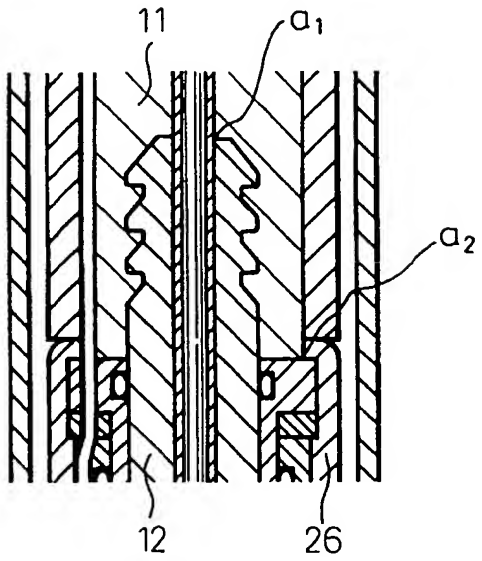


Fig.3B

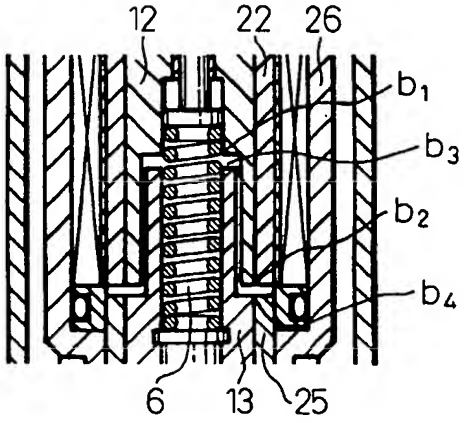


Fig.3C

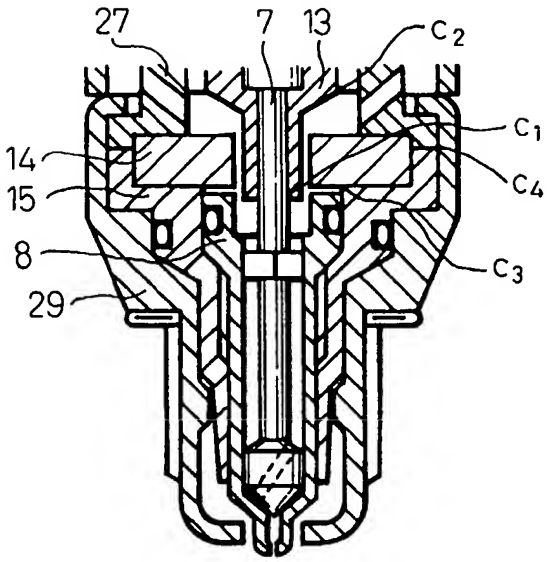


Fig.4

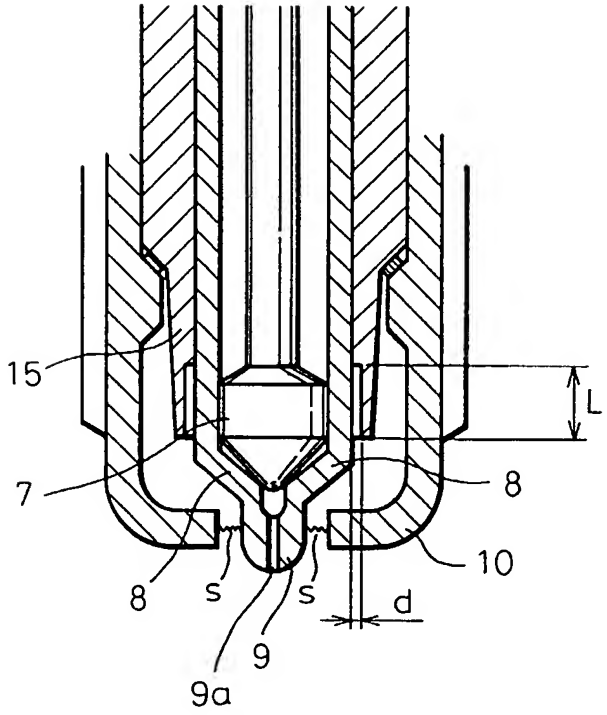
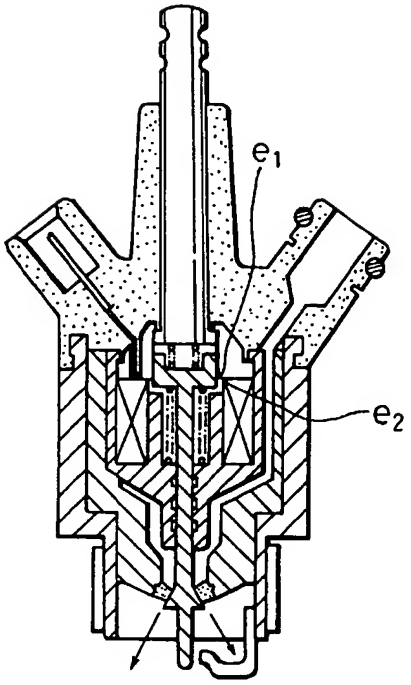


Fig.5



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